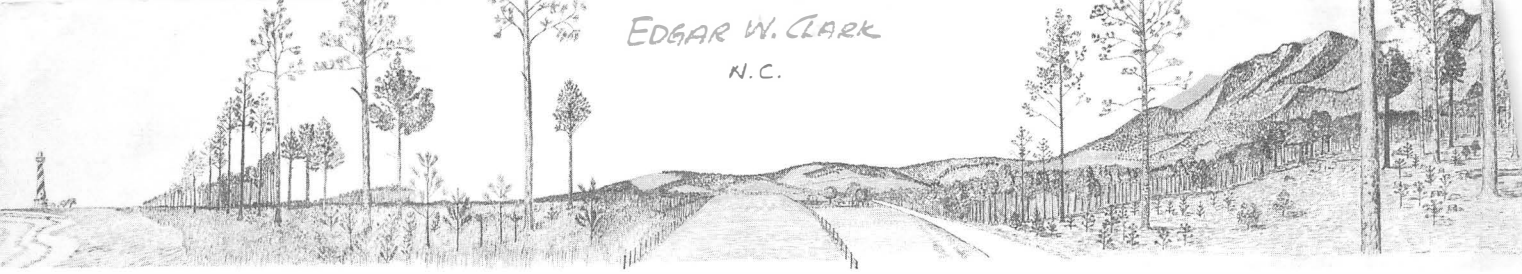

U. S. Forest Service Research Note SE- 45 July 1965

AN ARTIFICIAL DIET FOR THE SOUTHERN PINE BEETLE AND OTHER BARK BEETLES

Recently, Yearian and Wilkinson (1963, 1965) reported two artificial diets for Ips calligraphus Germ. in which larval survival averaged 30 and 50 percent, respectively. Only a few artificial diets have been described for bark beetles (Bedard 1961). No artificial diet has been reported for the southern pine beetle (Dendroctonus frontalis Zimm.).

Three earlier notes (Clark and Osgood 1964a, 1964b; Clark 1965) presented techniques for rearing the southern pine beetle and the coarse writing engraver. This note describes an artificial diet used primarily for the southern pine beetle but also useful for rearing Ips and many other bark beetles.

The artificial medium formula is given in figure 1. There are two variations of this medium; the only difference is that one contains homogenized inner pine bark and the other purified, finely ground cellulose. To prepare the bark medium, the inner bark is first homogenized in 100 ml. of distilled water until the particle size is less than 2 mm. and then the rest of the ingredients are blended with it. The amount of bark is not critical and is primarily dependent upon its waste content. For example, inner bark obtained from loblolly or shortleaf pine can be stored in a freezer for at least one month without apparent loss in nutrient value. Since our freezer desiccates this bark in time, only one-half the weight of desiccated bark is used, thus maintaining the same approximate weight of solids. Of course, when using dry bark, additional water is added to maintain the moisture content of the medium between 70 and 80 percent. Sorbic acid, an antimicrobial agent insoluble in water, is added as an ethanol solution. The agar, dissolved in 100 ml. of hot water, is blended last. The pH of the medium is ordinarily about 4.8, but if not, it can be adjusted with hydrochloric acid or potassium hydroxide. This medium is too viscous to pour and is therefore spooned into 15 x 100 mm. petri dishes and spread into a layer $\frac{1}{8}$- to $\frac{1}{4}$-inch thick. Solidification of the medium is delayed by immersing the blender jar, containing the medium, in water held at about 70° C.

The prepared petri dishes are set aside for 24 hours with the covers slightly ajar and covered with a clean cloth to allow excess moisture to evaporate. Free moisture condensing on the medium and petri dish is minimized by using glazed porcelain petri dish covers instead of glass covers. The porcelain covers allow excess moisture to pass through, thus maintaining an equable moisture condition in the dish. They are then used or stored in a refrigerator for periods of up to one month.

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Ingredient	Amount
Fresh pine bark or cellulose	40.0 gm.
Brewer's yeast	2.0 gm.
Glucose	3.0 gm.
Fructose	3.0 gm.
Sucrose	3.0 gm.
Starch	2.0 gm.
Casein hydrolysate	2.0 gm.
Wesson's salt mixture	0.25 gm.
Wheat germ oil	0.5 ml.
Cottonseed oil	0.5 ml.
Sorbic acid (20% ethanol w/v)	5.0 ml.
Agar	8.0 gm.
Water (distilled)	200 ml.

Figure 1.--Ingredients for an artificial medium for the southern pine beetle and other bark-feeding beetles.

Initially some difficulty occurred in homogenizing inner bark. The problem was solved, however, by cutting the bark into small pieces and homogenizing it with a blender (550 watts or better) in which the regular blade was replaced by a special blade assembly.

The cellulose variation of this medium utilizes purified cellulose instead of bark. This is a very fine powder and the diet is much easier to prepare and subsequently handle.

Microbial contamination is of little consequence if sorbic acid is used at a concentration of 0.2 percent and the pH of the medium is around 4.8. If the pH is shifted above approximately 5.5, or sorbic acid is not evenly distributed by mixing, a number of fungal contaminants such as Aspergillus, Rhizopus, and Penicillium develop with which the larvae cannot compete.

Fortunately, the larvae of the southern pine beetle and the coarse writing engraver are not cannibalistic and approximately 24 eggs or larvae may be placed in each petri dish in niches cut into the media with a wire loop or microspatula. The method of installing the eggs or larvae is very important for they must be literally embedded in the medium. The plug or flap, created when the niche is cut, is carefully replaced. This seals in the eggs or larvae at the bottom of the niche. If this is not done the young larvae work their way to the surface, cannot feed properly, and usually die.

After the eggs or larvae are embedded, the infested petri dishes of medium are kept in an incubator at 27° C. No illumination or specific relative humidity is maintained.

In our laboratory work with this medium the number of individuals reaching adulthood from several thousand eggs or young southern pine beetle larvae averaged over 20 percent. Mortality was usually attributable to poor handling techniques, the apparent inability of the larvae to re-enter the media after surfacing, or to free water. The presence of excessive free water, or a water content in the medium that exceeds 80 percent, is detrimental to the larvae and can cause their death. The developmental period and growth of the reared insects are well within the range of larvae found in natural conditions.

To date no oviposition has been obtained on this medium, either by freshly paired southern pine beetles or engraver beetles, or older gravid southern pine beetle females taken from infested bolts in which they were actively ovipositing. Eggs or larvae must be obtained from infested bark.

Bark-feeding flathead and roundhead borer larvae have also been easily reared on the bark medium. However, the larvae may have to be reared in individual petri dishes because of possible cannibalism and because the larger species require from one to two petri dishes of medium to complete their development.

Pales weevils, Hylobius pales (Herbst), are also easily reared on the bark medium; both adults and larvae readily feed on it. The females oviposit on or in this medium but the eggs must be removed, allowed to hatch on damp cotton, and the larvae returned to the medium.[1] As an adult diet, and for egg production, as many as six pairs can be confined to a petri dish. Under these conditions, the adults have a longevity of at least 6 months. The infested dishes are maintained at a temperature of about 22° C. Higher incubation temperatures seem detrimental to this species.

[1] Unpublished data from current research by G. E. Moore and H. A. Thomas, Forestry Sciences Laboratory, Durham, N. C.

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